Claims

I claim:

1. A method for approximating a target object's pose from a range measurement device generated image of a target environment comprising the steps of:

generating a range image of the target environment;

extracting a binary map from the range image;

determining the location of at least one target object silhouette;

iteratively applying stages of binary templates to each target object silhouette with each stage representing a range of possible poses of the target object; wherein each stage represents a higher spatial fidelity than the previous stage; such that each stage reduces a number of possible poses of the target object; and

approximating the target object's pose based on a set of binary templates that best matches the target object silhouette.

2. The method of claim 1 wherein the step of extracting a binary map from the range image is performed by filtering the range image to include silhouettes of objects located within a predetermined range of distances from the range measurement device.

3. The method of claim 1 wherein the step of determining the location of a target object silhouette is performed by applying an initial binary shape template to the binary map that is a largest circle that is contained in all silhouettes of the target object, regardless of orientation.

4. The method of claim 1 wherein the step of determining the location of the target object silhouette is performed by determining a base location of a predetermined component and fixing a location of the target object based on the base location.

5. The method of claim 1 wherein the stage of binary templates includes shape templates that represent a merger of all possible object silhouettes that result when the target object is rotated about all undetermined axes for a given stage of template application.

6. The method of claim 1 wherein the batch of templates includes mask templates that correspond to empty regions surrounding the target object.

7. The method of claim 1 wherein the step of applying the binary template to the target silhouette is performed by performing an XOR operation between pixels in the target object silhouette and the template and summing the results of the XOR.

8. The method of claim 1 comprising the step of computing a match score between the target object silhouette and the binary template and wherein poses represented by binary templates yielding relatively low scores are eliminated from consideration in a succeeding stage.

9. The method of claim 8 wherein the match score for each stage is computed based on a set of binary shape templates representing a that represent a merger of all possible object silhouettes that result when the target object is rotated about all undetermined axes for a given stage of template application and mask templates that represent empty regions surrounding the target object when it is in a corresponding pose.

10. The method of claim 1 wherein the step of determining the location of a target object silhouette determines the location of a plurality of target object silhouettes, each of which is treated with binary templates in parallel.

11. A method for approximating a target object's pose from a range measurement device generated image of a target environment comprising the steps of:

generating a range image of the target environment;

extracting a binary map from the range image by filtering the range image to include silhouettes of objects located within a predetermined range of distances from the range measurement device;

determining the location of a target object silhouette;

iteratively applying stages of binary templates to each target object silhouette with each stage representing a range of possible poses of the target object; wherein each stage includes shape templates that represent a merger of all possible object silhouettes that result when the target object is rotated about all undetermined axes for a given stage of template application and mask templates that correspond to empty regions surrounding the target object when it is in a corresponding pose; and wherein each stage represents a higher spatial fidelity than the previous stage such that each stage reduces a number of possible poses of the target object; and

approximating the target object's pose by computing a match score between the target object silhouette and the binary shape and mask templates and wherein poses represented by binary templates yielding relatively high scores are selected as the approximate target object pose.

12. The method of claim 11 wherein the step of determining the location of the target object silhouette is performed by applying an initial binary shape template to the binary map that is a largest circle that is contained in all silhouettes of the target object, regardless of orientation.

13. The method of claim 11 wherein the step of determining the location of the target object silhouette is performed by determining a base location of a

predetermined component and fixing a location of the target object based on the base location.

14. The method of claim 11 wherein the step of applying the binary template to the target silhouette is performed by performing an XOR operation between pixels in the target object silhouette and the template and summing the results of the XOR.

15. For use with a computer vision system, an apparatus for approximating a target object's pose from a range measurement device generated image of a target environment comprising the steps of:

a range image generator for generating a range image of the target environment;

a binary map extractor for extracting a binary map from the range image by filtering the range image to include silhouettes of objects located within a predetermined range of distances from the range measurement device;

a target object silhouette locator for determining the location of the target object silhouette;

a binary template applicator for iteratively applying stages of binary templates to each target object silhouette with each stage representing a range of possible poses of the target object; wherein each stage includes shape templates that represent a merger of all possible object silhouettes that result when the target object is rotated about all undetermined axes for a given stage of template application and mask templates that correspond to empty regions surrounding the target object when it is in a corresponding pose; and wherein each stage represents a higher spatial fidelity than the previous stage such that each stage reduces a number of possible poses of the target object; and

a pose selector for approximating the target object's pose by computing a match score between the target object silhouette and the binary shape and mask templates and wherein poses represented by binary templates yielding relatively high scores are selected as the approximate target object pose.

16. The method of claim 15 wherein the target object locator determines the location of the target object silhouette by applying an initial binary shape template to the binary map that is a largest circle that is contained in all silhouettes of the target object, regardless of orientation.

17. The method of claim 15 wherein the target object locator determines the location of the target object silhouette by determining a base location of a predetermined component and fixing a location of the target object based on the base location.

18. The method of claim 15 wherein the binary template applicator applies templates to the target silhouette by performing an XOR operation between pixels in the target object silhouette and the template and summing the results of the XOR.